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APPLICATION FOR LETTERS PATENT

for

**SUBPAD SUPPORT FOR A POLISHING APPARATUS INCLUDING
A NON-ADHESIVE SUBPAD SECURING ELEMENT, ASSEMBLIES
INCLUDING THE SUPPORT AND A SUBPAD, POLISHING APPARATUS
INCLUDING THE SUBPAD SUPPORT, AND METHODS**

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APPENDIX A

(CLEAN VERSION)

(Serial No. 09/652,878)

**SUBPAD SUPPORT FOR A POLISHING APPARATUS INCLUDING
A NON-ADHESIVE SUBPAD SECURING ELEMENT, ASSEMBLIES
INCLUDING THE SUPPORT AND A SUBPAD, POLISHING APPARATUS
INCLUDING THE SUBPAD SUPPORT, AND METHODS**

BACKGROUND OF THE INVENTION

[0001] Field of the Invention: The present invention relates to subpad supports in web format and belt format polishing apparatus. Particularly, the present invention relates to subpad supports including non-adhesive subpad securing elements and to polishing apparatus including the subpad supports. The present invention also relates to assemblies including a subpad and a subpad support of the present invention, as well as to methods of assembling a subpad with, securing a subpad to, removing a subpad from, and replacing a subpad on a subpad support of the present invention.

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[0002] State of the Art: Web format polishing apparatus typically include a wafer support and a polishing pad. The wafer support is typically configured to hold a semiconductor wafer, to bring the wafer into contact with the polishing pad, and to rotate the wafer while the wafer is in contact with the polishing pad so as to create friction between the wafer and the polishing pad and, thereby, effect polishing of one or more layers on the wafer. As used herein, the term "polishing" encompasses removal of material from a semiconductor wafer. "Polishing", as used herein, need not achieve a certain surface finish or planarity. A subpad, located on the opposite side of the polishing pad from the wafer support, is configured to prevent the formation of defects on a wafer secured to the wafer support during polishing thereof, as well as to cushion the polishing pad and wafer being polished so as to prevent damage to the wafer during polishing. The subpad is held in place by a subpad support and, conventionally, has been secured to the subpad supports by way of an adhesive material.

[0003] Fresh portions of a web format, film-type polishing pad are supplied by a supply reel of the web format polishing apparatus, while used portions of the web format polishing pad are taken up on a take-up reel of the apparatus. Typically, the positions of

supply reels and take-up reels on conventional web format polishing apparatus are fixed relative to the remainder of these apparatus.

[0004] As a subpad wears, it must be replaced. Typically, in order to remove a subpad from a web format polishing apparatus, the web format polishing pad must either be cut or slack formed in the polishing pad by, for example, loosening the web format pad from the supply reel of the polishing apparatus without winding the pad around the take-up reel. Creating slack in a web format polishing pad facilitates pulling of the polishing pad away from the subpad. When a web format polishing pad is cut or given slack, it is common that a portion of the polishing pad is damaged and, thus, that portion of the polishing pad is wasted. In addition, as the subpad is typically secured to the subpad support with an adhesive material, removal of the subpad from the subpad support is often very difficult since the subpad may rip or need to be scraped from the subpad support.

[0005] Belt format polishing apparatus are very similar to web format polishing apparatus, with the major exception being that the polishing pad is in the format of a continuous belt that may be recycled, rather than a web that is supplied from a supply reel and, after use, taken away on a take-up reel. In order to gain access to a subpad of a belt format polishing apparatus, the belt format polishing pad is removed from the polishing apparatus, which is time consuming and may result in damage to the pad, or the pad may be stretched, which may also damage the pad. Damage to a belt format polishing pad to remove and replace a subpad is, however, even more costly than damage to a web format polishing pad because a damaged belt format polishing pad must be completely replaced.

[0006] The inventor is not aware of a subpad support to which a subpad may be non-adhesively secured and from which a subpad may be readily removed. Moreover, the inventor is not aware of a web format or belt format polishing apparatus configured to facilitate subpad removal and replacement without a significant potential for damaging the polishing pad.

BRIEF SUMMARY OF THE INVENTION

[0007] The present invention includes a subpad support with a retention element for removably, non-adhesively securing a subpad thereto, as well as web format and belt format polishing apparatus including the subpad support.

[0008] The subpad support of the present invention includes a subpad supporting surface and a subpad retention element. The subpad supporting surface is configured to receive a backing of a subpad. The subpad retention element is configured to non-adhesively secure a subpad to the subpad support. The subpad retention element may be configured to at least partially engage a periphery of a subpad, mechanically engage a backing of a subpad, apply a negative pressure to a backing of a subpad through the subpad support, or otherwise non-adhesively secure a subpad to the subpad support.

[0009] The subpad support may also include one or more lips, columns, or other lateral confinement structures protruding from the supporting surface thereof and that are configured and located so as to at least partially prevent lateral movement of a subpad relative to the subpad support to which the subpad is secured.

[0010] To facilitate the releasable securing of a subpad to the subpad support, the subpad may include a substantially rigid structure on the backing thereof. The substantially rigid structure may be secured to the backing of the subpad or formed by a denser region of the material of the subpad. If the substantially rigid structure is secured to the backing of the subpad, a material such as a polymer, a metal, a glass, or a ceramic may be used as the substantially rigid structure.

[0011] Polishing apparatus including the subpad of the present invention are also within the scope of the present invention. A polishing apparatus incorporating teachings of the present invention may include a component that at least partially moves the polishing pad of the apparatus away from the subpad support thereof, as well as a subpad secured to the subpad support. In a web format polishing apparatus, such a component may include, by way of example only and not to limit the scope of the present invention, a releasable latch that secures one or both of the supply reel and the take-up reel to the remainder of the polishing apparatus. In addition, such an exemplary polishing apparatus

may also include a member that effects the controlled movement of one or both of the supply and take-up reels and, thus, the polishing pad away from the remainder of the polishing apparatus. Exemplary members include, but are not limited to, one or more hydraulic pistons, gear drive mechanisms, and screw drive mechanisms.

[0012] Methods of assembling and securing a subpad to the subpad support, removing a subpad from the subpad support, and replacing a subpad on the subpad support are also within the scope of the present invention, as are methods of at least partially moving a polishing pad away from a subpad support so as to facilitate such assembly, securing, removal, and replacing.

[0013] Other features and advantages of the present invention will become apparent to those of skill in the art through consideration of the ensuing description, the accompanying drawings, and the appended claims.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0014] FIG. 1 is a perspective assembly view illustrating an exemplary embodiment of a subpad support incorporating teachings of the present invention and a subpad configured to be secured to the subpad support by way of complementary threads on the subpad and the subpad support;

[0015] FIG. 2 is a perspective view of another exemplary embodiment of an assembly of a subpad support that includes a clamping member configured to engage at least a portion of a periphery of a subpad;

[0016] FIG. 3 is a cross-sectional representation of an embodiment of a subpad support-subpad assembly wherein the subpad support includes clamping members configured to engage recessed portions of a complementary subpad;

[0017] FIG. 4 is a cross-sectional representation of yet another exemplary embodiment of an assembly including a subpad support and a subpad of the present invention, wherein the subpad support is configured to apply a relatively negative pressure to the backside of the subpad to secure the subpad thereto;

[0018] FIG. 5 is a partial perspective view of an embodiment of a subpad support configured to slidably engage a complementarily configured subpad;

[0019] FIG. 6 is a partial top view of an embodiment of subpad support with recesses and slots configured to receive tabs protruding from the periphery of a complementarily configured subpad;

[0020] FIGs. 7A and 7B illustrate still another embodiment of subpad support and subpad incorporating teachings of the present invention, wherein the subpad support includes keyhole-shaped recesses configured to receive headed studs protruding from the backing of the subpad;

[0021] FIGs. 8 and 8A are schematic representations of a belt format polishing apparatus incorporating teachings of the present invention, depicting at least partial movement of the polishing pad thereof away from the subpad support thereof; and

[0022] FIGs. 9 and 9A are schematic representations of a belt format polishing apparatus incorporating teachings of the present invention, depicting movement of the polishing pad thereof away from the subpad support thereof.

DETAILED DESCRIPTION OF THE INVENTION

[0023] Referring to FIG. 1, a first exemplary embodiment of a subpad support 10 incorporating teachings of the present invention is illustrated. Subpad support 10 includes a supporting surface 12 and a retention element 14. Supporting surface 12 is configured to engage a backing 22 of a subpad 20. Retention element 14 is configured to secure subpad 20 to subpad support 10. Subpad support 10 may also include one or more lips 16 protruding therefrom and positioned so as to facilitate the alignment of subpad 20 with subpad support 10 during assembly thereof or to at least partially prevent lateral movement of subpad 20 relative to supporting surface 12 during use.

[0024] Retention element 14, as illustrated, is configured to mechanically engage a corresponding, complementary structure of a known type, such as the illustrated threaded locking element 24, on backing 22 of subpad 20. Upon interconnecting retention

element 14 and locking element 24 and rotating locking element 24 relative to retention element 14, retention element 14 and locking element 24 interlock so as to secure subpad 20 to subpad support 10.

[0025] As illustrated, locking element 24 is secured to a backing 22 of subpad 20 by known means, such as with a suitable adhesive. Alternatively, locking element 24 may be integral with backing 22. Backing 22 may be formed from a relatively denser region of the same material as the remainder of subpad 20, which may be formed from a material such as closed-cell polyurethane foam, and may be integral therewith, or may comprise a separate element secured to the remainder, or contact surface 23, of subpad 20. Alternatively, backing 22 may be formed from another polymer (e.g., polycarbonate), a metal, a ceramic, or any other suitable material, different from the material of contact surface 23, which cushions a wafer during polishing thereof. A backing 22 that is separate from the remainder of subpad 20 may be secured thereto as known in the art, such as by use of adhesives or by thermally bonding contact surface 23 of subpad 20 to backing 22 thereof.

[0026] Turning now to FIG. 2, another embodiment of a subpad support 10' according to the present invention is illustrated. Subpad support 10' includes a supporting surface 12' and a retention element 14'. Again, supporting surface 12' is configured to engage a backing 22' of a subpad 20' to be assembled with subpad support 10'. In addition, retention element 14' is configured to mechanically secure a subpad 20' to subpad support 10'.

[0027] Retention element 14' of subpad support 10' includes a clamping member 15' that is configured to be positioned around the periphery 21' of at least a rigid backing 22' of subpad 20' upon assembly of subpad 20' with subpad support 10' and to be biased against periphery 21' so as to secure backing 22' against supporting surface 12' while substantially maintaining the planarity of contact surface 23' of subpad 20' and, thus, the planarity of an area of a polishing pad to be supported by subpad 20'. In addition, clamping element 15' at least partially prevents lateral movement of subpad 20' relative to supporting surface 12'.

[0028] Again, subpad 20' includes a cushioning contact surface 23' and a substantially rigid backing 22'. Backing 22' may be formed from a dense region of the same material as contact surface 23' or from another material, such as another polymer, a metal, a ceramic, or another suitable material. If backing 22' is formed from the same material as contact surface 23', backing 22' may be integral with contact surface 23' or a separate element that is secured to contact surface 23'. Of course, if another material is used to form backing 22', backing 22' is secured to contact surface 23'. Backing 22' and contact surface 23' of subpad 20' may be secured to one another by known means, such as by use of a suitable adhesive material or by thermally bonding backing 22' and contact surface 23' to one another.

[0029] Another embodiment of subpad support 10'' is shown in FIG. 3. Subpad support 10'' includes a supporting surface 12'' that is configured to engage a backing 22'' of a subpad 20''. Subpad support 10'' also includes retention elements 14'' that are configured to clamp onto corresponding receptacles 26'' recessed in periphery 21'' of subpad 20''. Each receptacle 26'', along with backing 22'', forms a lip 27'', which a corresponding retention element 14'' engages upon being disposed in a clamping position. Upon engaging lips 27'' with retention elements 14'', backing 22'' of subpad 20'' is held against supporting surface 12'' of subpad support 10''.

[0030] FIG. 4 illustrates yet another embodiment of a subpad support 10''' incorporating teachings of the prevent intention. As the previously described subpad support embodiments, subpad support 10''' includes a supporting surface 12''' and a retention element 14'''. Subpad support 10''' may also include one or more columns 16''', lips, or other structures protruding from supporting surface 12'''. Columns 16''' are preferably configured so as to laterally surround a periphery 21''' of subpad 20''' upon assembly thereof with subpad support 10'''. Columns 16''' are configured to align a subpad 20''' with subpad support 10''', to substantially laterally surround a subpad 20''' assembled with subpad support 10''', or to at least substantially inhibit subpad 20''' from moving laterally relative to supporting surface 12'''.

[0031] Supporting surface 12''' is configured to engage a backing 22''' of a subpad 20''' upon assembly of subpad 20''' with subpad support 10'''.

[0032] Retention element 14''' employs a negative pressure to secure a subpad 20''' to subpad support 10'''. Retention element 14''' includes one or more apertures 30 formed through subpad support 10''' from supporting surface 12''' to an opposite surface 18'''. Apertures 30 communicate with a negative pressure, or vacuum, source 34 by way of a negative pressure conduit 32 between apertures 30 and negative pressure source 34. As illustrated in FIG. 4, retention element 14''' also includes a chamber 35 formed within subpad support 10''' and communicating with each aperture 30. In turn, chamber 35 communicates with conduit 32 by way of a connection port 37 on subpad support 10'''. Alternatively, each aperture 30 of a retention element 14''' incorporating teachings of the present invention may communicate with negative pressure source 34 by way of separate conduits 32. In any event, retention element 14''' secures a subpad 20''' to supporting surface 12''' of subpad support 10''' by applying a negative pressure to backing 22''' of subpad 20''' through apertures 30 formed in subpad support 10'''.

[0033] With reference to FIG. 5, a subpad support 110 configured to receive a rectangular subpad 120 is illustrated. Subpad support 110 includes a recessed retention element 114 that is continuous with at least one end of subpad support 110. Retention element 114 includes elongated retention slots 115 at opposite sides thereof. Retention slots 115 are configured to engage corresponding, opposite ends of a complementarily configured subpad 120 upon sliding subpad 120 in the direction of arrow A to position backing 122 of subpad 120 in substantial contact with supporting surface 112 of subpad support 110 and to effect engagement of subpad 120 by retention element 114. Accordingly, retention slots 115 may extend laterally beneath a supporting surface 112 of subpad support 110 so as to engage thin or tapered edges 125 of subpad 120.

[0034] As shown in FIG. 6, a subpad support 110' incorporating teachings of the present invention may include a subpad receptacle 115' formed in a supporting surface 112' of subpad support 110' and configured to receive at least a backing (not shown) of a

complementarily configured subpad 120'. In the illustrated embodiment of subpad support 110', retention elements 114' are disposed around the periphery 116' of receptacle 115' and include recesses 114a' and slots 114b' that are continuous with receptacle 115'. Recesses 114a' are formed in supporting surface 112' and, upon introduction of the backing of subpad 120' into receptacle 115', are configured to receive tabs 128' that protrude laterally from periphery 121' of subpad 120', in a plane substantially parallel to the plane of subpad 120', and are located proximate the backing of subpad 120'. Retention elements 114' also include slots 114b' that are continuous with recesses 114a' and that underlie supporting surface 112'. Upon sliding of subpad 120' in the direction of arrow B relative to subpad support 110', retention tabs 128' are positioned within slots 114b' and subpad 120' is engaged by subpad support 110'.

[0035] Another embodiment of subpad support 110" and complementary subpad 120" incorporating teachings of the present invention is illustrated in FIGs. 7A and 7B. Subpad support 110" includes a supporting surface 112" with a series of keyhole-shaped retention elements 114" formed therein. Retention elements 114" include an enlarged end 114a" and a narrower, elongated slot 114b" formed through and continuous with supporting surface 112", as well as a receptacle 114c" underlying supporting surface 112", enlarged end 114a", and elongated slot 114b". Enlarged end 114a" of each retention element 114" is configured to receive a head 128a" of a corresponding retention stud 128" that protrudes from a backing 122" of subpad 120". Slot 114b" is narrower than end 114a" and is configured to receive a neck 128b" of retention stud 128" as head 128a" is positioned within the portion of receptacle 114c" that underlies slot 114b". As shown in FIGs. 7A and 7B, retention elements 114", including slot 114b" and receptacle 114c" thereof, may be slightly curved so as to facilitate engagement of a subpad 120" by subpad support 110" upon slight rotation of subpad 120" in the direction of arrow C relative to subpad support 110". Alternatively, the slot and receptacle of a retention element 114" may be angled so as to facilitate the retention of a complementary retention stud 128" therein.

[0036] Referring now to FIGs. 8, 8A, 9, and 9A, subpad support 10 may be included in a web format polishing apparatus 40, illustrated in FIGs. 8 and 8A, or in a belt-type polishing apparatus 40', shown in FIGs. 9 and 9A.

[0037] As shown in FIG. 8, subpad support 10 of polishing apparatus 40 is positioned adjacent a web format polishing pad, which is referred to herein and known in the art as a "web" 42. Polishing apparatus 40 also includes a supply reel 44 from which fresh portions of web 42 are supplied, as well as a take-up reel 46, which receives previously used portions of web 42. In use of polishing apparatus 40, a semiconductor device structure 1 is brought into frictional contact with web 42, on an opposite side thereof from subpad support 10. As semiconductor device structure 1 is polished at least in part by web 42, the portion of web 42 that is being used to polish semiconductor device structure 1 is supported from beneath by a subpad 20 assembled with subpad support 10.

[0038] Web 42 and subpad 20 of polishing apparatus 40 are positioned in close proximity to one another. Polishing apparatus 40 includes a polishing pad movement element 50, which is also referred to herein as a subpad access element, to effect the movement of web 42 at least partially away from subpad 20 so as to avoid physical contact of an operator with web 42 while facilitating access to a worn or damaged subpad 20. As illustrated in FIGs. 8 and 8A, polishing pad movement element 50 is associated with at least one of supply reel 44 and take-up reel 46 of polishing apparatus 40. Polishing pad movement element 50 preferably effects the movement of web 42 away from subpad support 10 in a controlled manner and at a controlled rate to minimize stress on web 42. By way of example, and not to limit the scope of the present invention, known apparatus that may be used as polishing pad movement element 50 include hydraulic pistons, screw drive motors, gear drive motors, and the like. Polishing apparatus 40 may also include a latch 52 or other known releasable locking element that is configured to prevent movement of web 42 away from subpad 20 and subpad support 10 when such movement is not desired. In addition, if polishing pad movement element 50 moves one end 42a of web 42 while the other end 42b of web 42 remains substantially stationary, end 42b may be pivotally connected to apparatus 40, such as by a pivot pin 54

that connects one conveyor support 48 to a fixed structure of apparatus 40 or otherwise, as known in the art (see FIGs. 9 and 9A).

[0039] Referring now to FIGs. 9 and 9A, polishing apparatus 40' includes a belt format polishing pad, which is referred to herein and known in the art as a "belt" 42'. Belt 42' may be continually moved around conveyor supports 48 to supply fresh or newly conditioned portions of belt 42' for use in polishing a semiconductor device structure 1. As semiconductor device structure 1 is brought into frictional contact with belt 42' to effect polishing of semiconductor device structure 1, the portion of belt 42' that is being used to polish semiconductor device structure 1 is supported from beneath by a subpad 20 assembled with subpad support 10.

[0040] As shown in FIG. 9, belt 42' and subpad 20 are positioned very closely to one another. In order to avoid physical contact by an operator with belt 42' to gain access to a worn or damaged subpad 20 to remove and replace the same on subpad support 10, polishing apparatus 40' is supplied with a polishing pad movement element 50' that effects the movement of belt 42' at least partially away from subpad 20. As illustrated in FIGs. 9 and 9A, polishing pad movement element 50' is associated with at least one conveyor support 48 of polishing apparatus 40'. Polishing pad movement element 50' preferably effects the movement of belt 42' away from subpad support 10 in a controlled manner and at a controlled rate. Examples of known apparatus that are useful as polishing pad movement element 50' include hydraulic cylinders, pneumatic cylinders, screw drive motors, gear drive motors, and the like. Polishing apparatus 40' may also include a latch 52' configured to prevent movement of belt 42' away from subpad 20 and subpad support 10 when such movement is not desired. In addition, if polishing pad movement element 50' moves one end 42a' of belt 42' while the other end 42b' of belt 42' remains substantially stationary, end 42b' may be pivotally connected to apparatus 40', such as by a pivot pin 54' that connects one conveyor support 48 to a fixed structure of apparatus 40' or otherwise, as known in the art.

[0041] An example of the manner in which a subpad 20 is removed from subpad support 10 of polishing apparatus 40' and replaced on subpad support 10 is described with

continued reference to FIGs. 9 and 9A. Latch 52' of polishing apparatus 40' is positioned so as to facilitate the movement end 42a' of belt 42' while end 42b' of belt 42' pivots around pivot pin 54', thereby at least partially moving belt 42' away from subpad 20 and subpad support 10 so as to facilitate access to subpad 20. Belt 42' is then at least partially moved away from subpad 20 and subpad support 10 with the assistance of or by way of polishing pad movement element 50'. Of course, apparatus 40' could be configured such that both ends 42a', 42b' of belt 42' may be moved so as to effect movement of belt 42' away from subpad support 10. Next, subpad 20 is released by retention element 14 (*see, e.g.*, FIGs. 1-3) and disassembled from subpad support 10. Another subpad 20 may be assembled with subpad support 10 and secured thereto by retention element 14. Belt 42' may then be repositioned adjacent subpad 20 and subpad support 10 with the assistance or by way of polishing pad movement element 50'. Latch 52' may be repositioned so as to secure belt 42' in place.

[0042] Although the foregoing description contains many specifics, these should not be construed as limiting the scope of the present invention, but merely as providing illustrations of some of the presently preferred embodiments. Similarly, other embodiments of the invention may be devised which do not depart from the spirit or scope of the present invention. Features from different embodiments may be employed in combination. The scope of the invention is, therefore, indicated and limited only by the appended claims and their legal equivalents, rather than by the foregoing description. All additions, deletions and modifications to the invention as disclosed herein which fall within the meaning and scope of the claims are to be embraced thereby.